Perinatal Mortality and Survival

PART II—COMPARISONS BETWEEN POPULATION GROUPS

THEODORE A. MONTGOMERY, *M.D., M.P.H.*, MARJORIE HAMMERSLY, *B.A.*, and ARLINE LEWIS, *M.P.H.*, Berkeley

• **If the time span of risk of perinatal death is defined as the period from 20 weeks gestation through 27 days after birth, 97 out of 100 infants born in California during 1959 were born alive and survived the first month of life. The California State Department of Public Health made an analysis of descriptive items from 358,388 birth and 10,916 death certificates to identify demographic characteristics associated with perinatal mortality and survival. Maturity of the infant was the single most important factor; two-thirds of all perinatal mortality was among infants weighing 2,500 grams or less. An infant premature by any two of three criteria (birth weight, birth length or gestation) had less chance of surviving than an infant premature by only one; infants premature by all three measures had the poorest prospect of being born alive and surviving one month. Nonwhite premature infants fared better than white; Oriental infants of all weights showed remarkable survival capacity. Female infants of all races had a survival advantage over males up to weights of 4,501 grams or more.**

Certain "high-risk" groups of infants were identified: Infants premature by more than one criterion, Negro infants, infants who were one of a set of twins or triplets, infants born to older mothers or to very young multiparae, infants of mothers with four or more previous live births, those born by cesarean section, infants of families in low income occupations, infants of military personnel, infants born in county or federal hospitals, those born outside a hospital, those born to mothers who had no prenatal care and those born in northern, mountain counties.

WHAT ARE SOME of the characteristics of babies who live at least one month after birth as distinguished from those who do not survive? The California State Department of Public Health has made an analysis of descriptive items from 369,304 birth and death certificates of infants born in 1959 and of 252,400 certificates of those born in 1949 in order to identify demographic characteristics associated with perinatal mortality and survival. Part I of this report discussed differences found between the two years for (1) proportions of fetal deaths, neonatal deaths and surviving infants among population groups; (2) for causes of perinatal deaths; and (3) for geographic areas. The following report presents more detailed data for perinatal mortality and survival in California for all births that occurred during 1959 and identifies "high-risk" groups of infants.

Many factors of heredity and environment determine the death or survival of an individual child; however, certain groups of infants show a greater capacity for withstanding prenatal and natal hazards than others.

If the time span of risk of perinatal death is defined as the period from 20 weeks gestation through 27 days after birth, 97 out of 100 infants born in California during 1959 were born alive and survived their first month. Of all the race, sex and weight groups studied the one with the best survival (99.8 per cent of total births) was 621 female Oriental infants with an average weight of 3,375 grams (7 lbs. 6 ozs.); only one fetal death and no neonatal deaths were recorded among this group.

Fetal and neonatal death rates were the lowest in California's history. Compared with the majority of other states, neonatal death rates were low, although not as favorable as in 13 other states. There were also several other countries where more newborns survived their first month than in California. Table 1 shows comparisons of high and low rates.

From the Bureau of Maternal and Child Health, California State Department of Public Health, Berkeley 94704.

Submitted February 21, 1963.

Part I (Statistical Trends) appeared in CALIFORNIA MEDICINE, 99:184-188, September, 1963.

Some of the characteristics most strongly associated with infant survival or loss are discussed in the following sections.

Maturity at Birth

The most critical factor in the infant's ability to survive is maturity. Birth weight is a convenient and internationally used criterion of prematurity; however, there is obviously a range of individual differences around the usual standard of 2,500 grams or less. Chart 1 shows differences in survival by sex and race at given weights; there is considerable variation, especially at low weights.

DEFINITIONS

Live birth—The birth of an infant, irrespective of duration of pregnancy, which after complete separation from its mother shows any evidence of life.

Fetal death—The death of a fetus which after complete birth shows no evidence of life. In California, if it is of 20 or more weeks gestation it must be registered.

Total births—Live births plus fetal deaths.

Neonatal death—The death of a liveborn infant in the first 27 days after birth.

Perinatal death—A death around the period of birth. In this report, a perinatal death is either a fetal or a neonatal death.

Surviving infant—An infant who is alive 28 days after birth. Survival percents are calculated from total births (including both fetal deaths and live births). This gives a measure of an infant's chances of being born alive and living at least 27 days after birth.

TABLE 1.—*Comparative Neonatal Mortality Rates: States and Nations* with Lowest and Highest Neonatal Mortality Rates, 1959*

State or Nation	Neonatal Death Rate	Rank Order from Lowest Rate
States, District of Columbia		
Utah	15.3	1
California	17.3	14
Washington, D.C.	27.6	51
Nations		
Netherlands	12.0	1
United States	19.1	14
Tunisia	40.6	40

*As reported to the World Health Organization; Reports not received from all nations.

Source: U.S. Department of Health, Education, and Welfare, National Office of Vital Statistics, Vital Statistics of the United States, 1959, Section 6.

World Health Organization, Epidemiological and Vital Statistics Report, 14:6:193-195, 1961.

Length at birth and weeks of gestation are indices of prematurity also available from California birth certificates. A combination of these three measures of prematurity appears to be a more accurate predictor of mortality than weight alone. In 1959, an infant premature by any two of these criteria had less chance of surviving than the infant premature by only one; and an infant premature by all three measures had the poorest prospect for being born alive and surviving the first month. (See Table 2.)

Race and Sex Differences

Of every 100 births of each race, three white, five Negro and two Oriental or other nonwhite (mainly American Indian) were either born dead or died in the first month after birth. Nonwhites other than Negroes had a better chance for survival than whites; Negroes had the poorest survival, with higher than average proportions of both fetal and neonatal deaths (See Table 3).

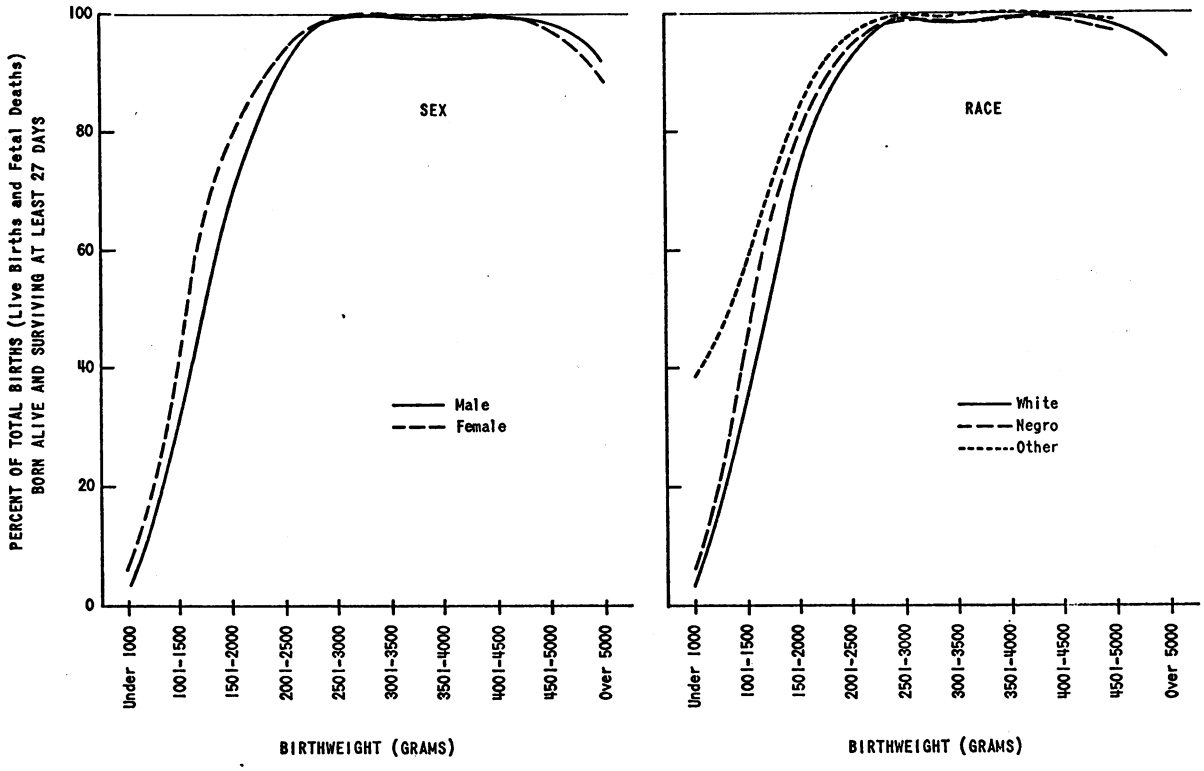

Chart 1.—Sex and Race as Factors in Infant Survival (Deaths of Infants Born in California During 1959).

TABLE 2.—Outcome of Births: Three Criteria of Prematurity

Criteria of Prematurity	Total Births (Live Births+ Fetal Deaths)	Per Cent of Total Births		
		Fetal Death	Neonatal Death	Surviving Infant
Weight,* length,† and gestation‡	10,555	13.9	24.6	61.5
Weight and gestation	13,783	12.6	22.6	64.8
Length and gestation	12,372	12.5	21.3	66.2
Weight and length	19,452	11.4	18.4	70.2
Weight only	28,469	9.8	15.6	74.6
Gestation only	29,731	7.0	11.6	81.4
Length only	33,847	7.2	11.0	81.8

*2,500 grams or less.
†Less than 18½ inches.
‡Under 37 weeks.

Female infants of all races had a consistent survival advantage over males up to birth weights of 4,501 grams or more (Chart 1). Nonwhites other than Negroes had the best survival at all birth weights, but particularly for infants in the small weight groups. California data confirm observations made elsewhere in the United States[2] that where whites and Negroes use the same hospitals, the survival of Negro prematures is better than that of whites for each 500 gram weight category of 2,500 grams or less.

Because two-thirds of all fetal and neonatal deaths were associated with prematurity, the incidence and survival of infants weighing 2,500 grams or less was an important factor in the total perinatal mortality record for each sex and race. (Note: Data in the following sections will use weight as the measure of prematurity.) Incidence of these low-weight births varied from 6.8 per cent for white males to 14.6 per cent of female Negro infants (See Table 4). More females than males were premature by the weight criterion, but the survival of female prematures was better than for males.

Age of Mother and Previous Live Births

The older the mother and the larger her number of previous deliveries, the higher the incidence of perinatal mortality, even when these two factors were considered independently. The relative importance of fetal and neonatal deaths in total mortality was different for each decade of the mother's childbearing years (Chart 2). Neonatal death rates (deaths per 1,000 live births) were higher among infants of young mothers; fetal death rates were higher among those whose mothers were 40 years of age and over.

In 1959, one in every seven births was to a mother under 20; one-third of these women already had at least one previous delivery of a living infant. While fetal death rates were low for very young mothers, neonatal death rates increased rapidly with each birth (Chart 2). These mothers were more apt to have babies premature by weight than the average of mothers of all ages (9.0 per cent compared with 7.8 per cent). They were more likely to have late or no prenatal care (14.0 per cent compared with the average of 10.2 per cent of live births).

First-born children of mothers who had reached the mid-twenties had lowered survival chances. However, since previous live births (rather than number

TABLE 3.—Outcome of Births (All Weights): Sex and Race

Sex and Race	Total Births (Live Births+ Fetal Deaths)	Per Cent of Total Births		
		Fetal Death	Neonatal Death	Surviving Infant
Male	186,466	1.4	1.9	96.7
White	166,186	1.3	1.9	96.8
Negro	14,381	2.2	2.8	95.0
Oriental	3,587	0.6	1.2	98.2
Other nonwhite	2,312	0.8	1.0	98.8
Female	176,646	1.2	1.5	97.3
White	157,029	1.2	1.4	97.4
Negro	14,151	2.1	2.2	95.7
Oriental	3,343	0.5	0.9	98.6
Other nonwhite	2,123	1.2	0.8	98.0

TABLE 4.—Outcome of Premature* Births: Sex and Race

Sex and Race	Per Cent of Total Births Premature	Total Premature Births (Live Births+ Fetal Deaths)	Per Cent of Total Premature Births		
			Fetal Death	Neonatal Death	Surviving Infant
Male	7.3	13,569	11.0	18.5	70.5
White	6.8	11,313	11.3	19.1	69.6
Negro	12.4	1,788	10.3	17.4	72.3
Oriental	7.8	280	4.6	10.0	85.4
Other nonwhite	8.1	188	5.3	8.5	86.2
Female	8.4	14,900	8.7	12.9	78.4
White	7.8	12,305	8.8	13.3	77.9
Negro	14.6	2,066	9.1	12.1	78.8
Oriental	9.6	320	3.1	7.8	89.1
Other nonwhite	9.8	209	6.2	5.3	88.5

*2,500 grams or less.

TABLE 5.—High-Order Live Births: Father's Occupation and Race

Father's Occupation*	Per Cent of Mothers with Four or More Previous Live Births			
	Total	White	Negro	Other Nonwhite
All occupation groups	13.4	12.4	24.6	12.9
Professional	9.9	10.0	.....†	5.1
Technical, administrative, managerial	10.4	10.4	15.8	6.3
Clerical, sales, skilled workers	11.5	10.9	22.2	11.8
Semiskilled	14.8	13.5	24.8	17.6
Nonfarm laborers	23.9	20.7	32.7	17.6
Farm laborers	33.5	33.2	45.0	29.0
Military personnel	8.5	7.8	13.5	10.7

*Based on a 10 per cent sample of 1959 live births. Only those groups with 1,000 births in sample are shown.
†Fewer than 50 births in sample; per cent not computed.

of pregnancies) was the measure of birth order, some of these women may have had previous fetal losses, which was a factor associated with increased mortality risks for the present infant. It is of interest that in 1959 there were 17 mothers aged 45 or over who had had no previous live births; among the infants of this group there were no fetal deaths and all survived the first month.

High-order births (defined here as births to mothers with four or more previous live births) were associated with increased fetal and neonatal death rates. Like most of the study findings, the relationship between high-order births and mortality was not a simple one. In addition to the obvious association of high-order births with older mothers, there was also an association with Negro race, low-income occupation group (Table 5) and late or no prenatal care.

Multiple Births

Among live births, 2.0 per cent of whites, 2.8 per cent of Negro and 1.5 per cent of other non-white infants were one of a set of twins or triplets. Since more than half of these multiple births were premature (compared with 6.9 per cent of single births), the over-all risk of perinatal mortality was greater among these infants. However, for each 500-gram weight category between 1,000 and 2,750 grams, more infants of multiple births survive than do infants of single births of the same weight (Table 6).

TABLE 6.—*Outcome of Births: Multiple* and Single Births*

Multiple, Single Births	Total Births (Live Births + Fetal Deaths)	Per Cent of Total Births		
		Fetal Death	Neonatal Death	Surviving Infant
All multiple births	7,773	3.6	9.1	87.3
Premature multiple births	4,123	5.6	16.1	78.3
All single births	355,339	1.3	1.5	97.2
Premature single births	24,346	10.5	15.5	74.0

*One of a set of twins or triplets.

Father's Occupation Group

The incidence of premature births according to weight criterion increased with decrease in income level as measured by occupation of father (Table 7). The exception was infants of farm laborers; this may be due to the low prematurity rate found among Mexican-born mothers. Both nonfarm and farm labor groups had high neonatal and fetal death rates; the farm group had a particularly high fetal death rate. Infants of military personnel, whether the births occurred in federal hospitals or private hospitals, had a relatively high neonatal death rate.

Prenatal Care

Live birth and fetal death certificates give the month of pregnancy prenatal care began, but provide no information about type or continuity of

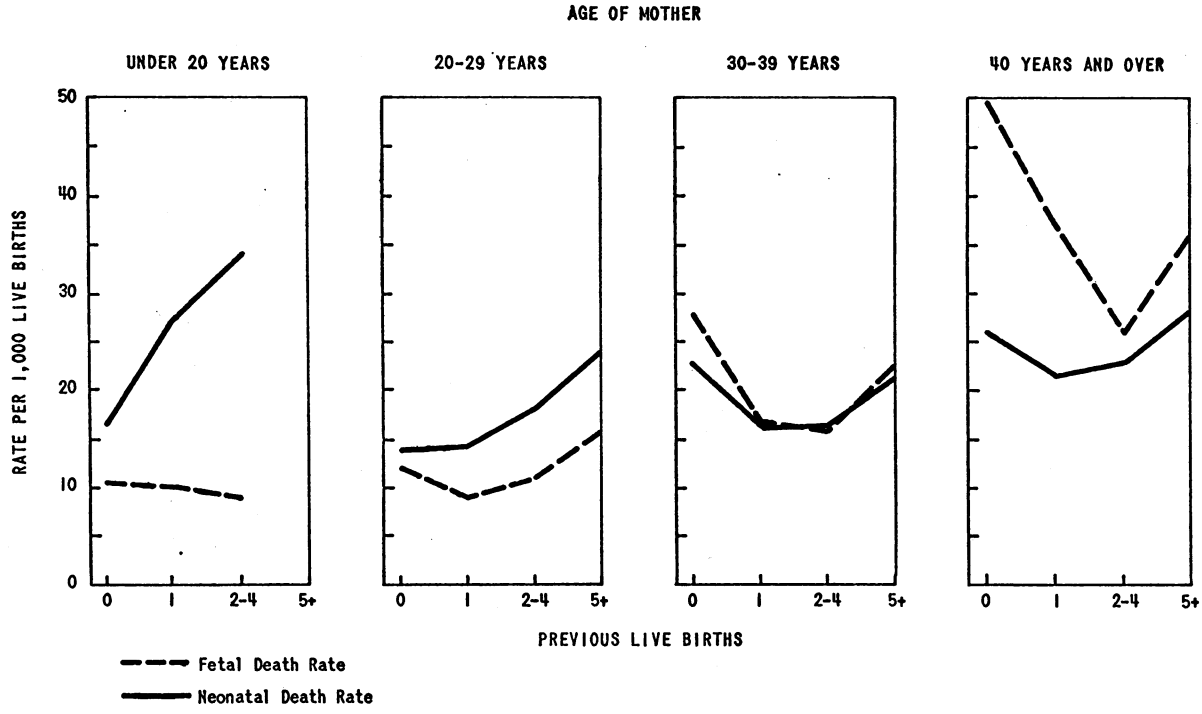

Chart 2.—Fetal and Neonatal Death Rates—Age of Mother and Previous Live Births (Deaths of Infants Born to California Residents During 1959).

TABLE 7.—*Fetal and Neonatal Death Rates and Per Cent of Live Births Premature: Father's Occupation Group*

Occupation Group	Fetal Deaths		Neonatal Deaths		Per Cent of Live Births 2,500 Grams or Less
	Rate*	S.E.†	Rate*	S.E.†	
Professional	9.5	.58	13.9	.70	5.1
Technical, administrative, managerial	11.0	.51	13.0	.56	5.9
Clerical, sales, skilled	12.4	.33	16.1	.38	6.8
Semiskilled	13.7	.45	18.8	.53	7.9
Nonfarm laborer	16.2	.66	19.1	.72	9.2
Farm laborer	20.2	1.30	19.6	1.28	6.6
Military personnel	12.4	.57	20.4	.73	8.0

*Rate per 1,000 live births based on a 10 per cent sample of 1959 births. Only those occupation groups with 1,000 births in sample included.

†Standard error.

supervision. Accuracy of this item is often limited by the mother's memory or by medical care records covering only part of the pregnancy; this was one of the certificate items found to agree least often with hospital records for San Francisco births.[1] No information about month of first care was given for 1.9 per cent of 1959 live births, 16.4 per cent of fetal deaths.

In a 10 per cent sample of 1959 live births in California:

- Women delivered in private hospitals obtained prenatal care most often in the first trimester (69.9 per cent of white births, 51.6 per cent of Negro). For private hospital births, only 5.3 per cent of the mothers began care as late as the third trimester or failed to receive any care.

- Among county hospital births, 22.5 per cent of mothers had late care (third trimester) and an additional 15.9 per cent had no care before delivery.

- Women with four or more previous live births waited until the last three months (15.2 per cent) or had no care (6.8 per cent) more often than women with fewer previous births. (Delay by multiparae was found for private hospital births as well as others.)

- Of all age groups, mothers under 20 were most apt to have late care (10.8 per cent) or no care (3.2 per cent).

Table 8 shows outcome of births by the trimester in which the mothers began prenatal care. In order to make comparisons between births with prenatal care beginning early in pregnancy (first trimester) and those with care late in pregnancy (third trimester), data are presented separately for women whose pregnancies had reached the third trimester before delivery (26-36 weeks) or had reached term (37 weeks or more).

TABLE 8.—*Outcome of Births: Weeks of Gestation and Trimester Prenatal Care Began*

Weeks of Gestation and Trimester Prenatal Care Began	Total Births (Live Births + Fetal Deaths)	Per Cent of Total Births		
		Fetal Death	Neonatal Death	Surviving Infant
All Births	363,112*	1.3	1.7	97.0
First trimester	222,942	1.0	1.6	97.4
Second trimester	95,746	1.0	1.6	97.4
Third trimester	27,552	0.9	1.1	98.0
No prenatal care	9,267	4.3	5.4	90.3
Not stated	7,605	10.2	3.3	86.5
Births of 26-36 Weeks Gestation†	27,957	5.5	9.0	85.5
First trimester	15,626	5.2	9.5	85.3
Second trimester	8,127	4.2	8.9	87.0
Third trimester	2,188	3.0	4.8	92.2
No prenatal care	1,522	7.6	10.4	82.0
Not stated	494	40.5	8.5	51.0
Births of 37 or More Weeks Gestation	285,542	0.6	0.5	98.9
First trimester	180,250	0.5	0.5	99.0
Second trimester	76,302	0.5	0.6	98.9
Third trimester	21,617	0.6	0.6	98.8
No prenatal care	4,973	1.0	1.1	97.9
Not stated	2,400	9.2	0.9	89.9

*Includes 49,613 births of less than 26 weeks gestation or with gestation not reported.

†26-36 weeks considered to be the third trimester of pregnancy.

TABLE 9.—*Outcome of Births: Type of Hospital*

Type of Hospital	Total Births (Live Births + Fetal Deaths)	Per Cent of Total Births		
		Fetal Death	Neonatal Death	Surviving Infant
All Births	363,112	1.3	1.7	97.0
All premature births	28,469	9.8	15.6	74.6
County hospitals	45,623	2.0	2.4	95.6
Premature births	5,303	10.3	15.6	74.1
Federal hospitals	17,687	1.2	2.1	96.7
Premature births	1,529	8.5	18.8	72.7
Other tax-supported hospitals	32,992	1.2	1.5	97.3
Premature births	2,301	9.6	14.8	75.6
Private proprietary hospitals	202,174	1.1	1.5	97.4
Premature births	14,412	9.3	15.4	75.3
Private profit hospital	60,256	1.2	1.6	97.2
Premature births	4,345	9.9	14.9	75.3
Not in hospital	4,380	3.9	3.7	92.4
Premature births	579	18.1	21.1	60.8

For pregnancies of 37 weeks or more, infants of mothers with early care had slightly lower death rates and higher survival rates than those who had late prenatal care.

However, for infants born during the third trimester of pregnancy (26-36 weeks), death rates were lower for those whose mothers did not start care until the third trimester, with a necessarily short period of medical supervision. One possible explanation for the higher death rate found in the early care group is that those woman having complications seek medical care early in pregnancy, but still produce a high-risk group of infants because

of the complications. Another factor which might cause differences in rates is under-reporting of fetal deaths among women not under medical supervision.

Infants born to mothers with no prenatal care had high fetal and neonatal death rates whether pregnancy had reached term or not.

Type of Hospital

Mortality and survival data presented in Table 9 refer to hospital of birth rather than death. Some hospitals had few deaths because of their policy of transferring premature or ill infants for specialized care.

For infants born in county hospitals fetal and neonatal death rates were relatively high compared with private hospitals and other tax-supported hospitals except federal facilities. Births in county hospitals represented a concentration of "high-risk" groups of infants. In 1959, county hospital deliveries accounted for 12.5 per cent of all live births in California but they included:

- 50.8 per cent of all Negro births
- 79.9 per cent of all births with no prenatal care
- 27.2 per cent of all births to mothers with four or more previous live births
- 26.5 per cent of all births to families of semiskilled workers, farm and nonfarm laborers
- 18.5 per cent of premature births (2,500 grams or less)

Among premature infants of all races born in county hospitals, fetal death rates were higher, neonatal death rates the same as the state average. However, for white prematures born in county hospitals, both fetal and neonatal death rates were above the average rates of all white prematures. For Negro premature infants born in county hospitals, both fetal and neonatal death rates were similar to those for Negro prematures born in other types of hospitals.

Births in federal (mainly military) hospitals include a slightly higher than average proportion of prematures (8.6 per cent of 1959 total births, compared with the average 7.8). The neonatal death rate of these premature infants was the highest of all types of hospitals.

Of babies born outside a hospital, four out of 100 were born dead and another four died in the first month. Many of these may have been emergency deliveries; 13.2 per cent (almost twice the incidence for hospital births) weighed 2,500 grams or less.

Births by Cesarean Section

For 1959 live births, the incidence of cesarean section varied from 3.4 per cent in county hospitals to 5.0 per cent in private hospitals; 4.2 per cent of mothers under 35 years of age were delivered this way compared with 7.9 per cent of mothers 35 and over. Survival of infants delivered by section was lower than for other infants at all birth weights up to 500 grams. (See Table 10.)

TABLE 10.—*Outcome of Births: Cesarean Section and Other Delivery*

Type of Delivery	Total Births (Live Births + Fetal Deaths)	Per Cent of Total Births: Fetal Death	Neonatal Death	Surviving Infant
All births by cesarean section	17,236	2.3	3.9	93.8
Premature births by cesarean section	2,171	8.0	20.2	71.8
All other delivery	345,876	1.3	1.6	97.1
Premature births by other delivery	26,302	9.9	15.2	74.9

TABLE 11.—*Cause of Fetal Deaths*

Cause of Fetal Deaths	Number	Per Cent	Rate per 1,000 Live Births
ALL CAUSES	4,724	100.0	13.2
Chronic disease in mother	170	3.6	0.5
Acute disease in mother	36	.8	0.1
Diseases and conditions of pregnancy and childbirth	333	7.0	0.9
Difficulties in labor	347	7.3	1.0
Other causes in mother	45	1.0	0.1
Placental and cord conditions	2,078	44.0	5.8
Birth injury	47	1.0	0.1
Congenital malformation of fetus	305	6.5	0.8
Ill-defined causes	1,363	28.9	3.8

TABLE 12.—*Cause of Neonatal Deaths*

Cause of Neonatal Deaths	Number	Per Cent	Rate per 1,000 Live Births
ALL CAUSES	6,192	100.0	17.3
Congenital malformations	887	14.3	2.5
Birth injury	1,042	16.8	2.9
Atelectasis	1,570	25.4	4.4
Other diseases of early infancy	817	13.2	2.3
Prematurity unqualified or with subsidiary condition	1,301	21.0	3.6
Pneumonia of newborn	285	4.6	0.8
Other respiratory disease	15	.2	....
Diarrhea and gastritis	21	.3	0.1
Other infections	94	1.5	0.3
All other causes	160	2.6	0.4

*Less than 0.1.

Cause of Death

The most frequently reported cause of fetal death in 1959 was placental or cord conditions (44.0 per cent of all deaths). In 28.9 per cent, the cause was ill-defined or unknown or was reported only as prematurity. Autopsy findings were used to establish cause of death in 27.5 per cent of the cases. However, even when autopsy findings were used, there was often no certainty about the exact cause. Weaknesses of the fetus from defective germ cells, deficiencies of the intra-uterine environment and the

hazards of change from intra-uterine to extra-uterine life present a complicated set of circumstances. Therefore, knowledge of the actual causes of fetal death is meager and medical certification and methods of classifying these causes are difficult.

The most frequently recorded cause of neonatal death in 1959 was atelectasis (25.4 per cent). About one-fifth of all deaths were attributed to prematurity with no further information. Autopsies were used more frequently (46.3 per cent) in establishing diagnosis than for fetal deaths. Most of the deaths occurred shortly after birth—70.0 per cent in the first two days, 21.5 per cent between two days and one week and 8.5 per cent in the following three weeks.

Cause of perinatal deaths was analyzed for age of mother, previous live births, race, occupation group and type of delivery. No important differences were found. (See Tables 11 and 12.)

Geographic Area

Except for higher than average neonatal death rates in the northern mountain counties, there appeared to be no consistent urban-rural differences when five-year average (1955-1959) perinatal death rates were studied. Some major metropolitan counties had higher rates than counties surrounding them. There appeared to be little association between fetal and neonatal death rates in individual counties. Some areas with high neonatal rates had low fetal death rates.

Bureau of Maternal and Child Health, California State Department of Public Health, 2151 Berkeley Way, Berkeley, California 94704 (Montgomery).

REFERENCES

1. Montgomery, T. A., Lewis, A., and Hammes, L.: Evaluation of medical and health data on California's certificates of live birth, Calif. Med., 96:190-195, March 1962.

2. Wegman, M.: Weight at birth and survival of the newborn, Pediatrics, 14:396, 1954.